OBSERVATIONS ON THE CRUSTACEAN FAUNA OF NICKAJACK CAVE, TENNESSEE, AND VICINITY.

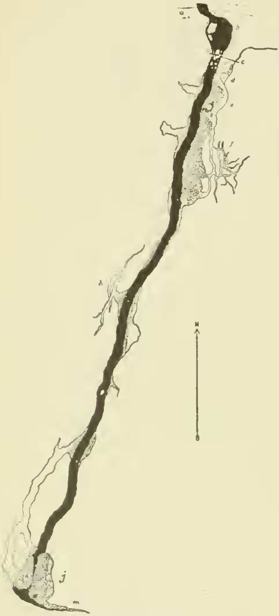
By William Perry Hay,
Of Howard University, Washington City.

I.—INTRODUCTION.

During the summer of 1901 the writer was able to visit Chattanooga, Tennessee, for the purpose of examining certain caverns in that region and making collections of the crustacean fauna. Like most other parts of the country in which limestone abounds, the region is full of caves, some ten or more being easily accessible from Chattanooga. Of these only a few have been visited by collectors. Owing to lack of time the writer was forced to pay attention only to the better-known caves, a brief description of which follows.

Nickajack Cave is situated near Shellmound, Tennessee, a small station on the Nashville, Chattanooga, and St. Louis Railroad, about 20 miles southwest of Chattanooga; it may also be located about one-fourth of a mile north of the point where the south line of Tennessee is joined by the boundary line between Georgia and Alabama. Here is also the end of Sand or Raccoon Mountain, a long ridge, which for many miles separates the drainage basin of the Tennessee River from that of the streams which flow into the Gulf of Mexico, a broad, flat-topped ridge with a foundation of limestone and a superstructure of the sandstone. It rises rather abruptly from the narrow river valley to a height of over 1,700 feet.

The mouth of the cave, which by the removal of a few trees has been made easily visible from the railroad, lies at the base of the north point of Sand Mountain, and the passage seems to extend straight back along the axis of the ridge. In size and impressiveness the entrance far surpasses that of any other American cavern, and alone should make Nickajack a point of interest. It is about 200 feet wide and 75 feet high from the surface of the cave stream to the ceiling. About half the width is taken up by the gorge through which the stream flows; the remainder is filled to a height of probably 50 feet with a mass of clay and rocks. The mouth of the stream is obstructed with great masses of rock, which make entrance at that point almost impossible. Taking the path on the left-hand side of the entrance, the visitor follows close to the wall for a distance of about 100 yards to the brink of a steep hill. Here the path divides, one branch leading down the hill to a flat floor only a few feet above the stream; the other still follows the wall and soon enters a crevice, which, in turn, leads to a labyrinth of low, tortuous passages. From the labyrinth one may return to the main cave again by a rough climb over a great heap of fallen stone, the exit being into an enormous room 100 feet wide and long, and 60 feet high, in which hundreds of bats have congregated. From this room the path leads down the side of the rocky hill to the water's edge and joins the other branch of the original path, which was left on the right on entering the labyrinth. From here on the cave is much smaller, the width has decreased to about 30 feet and the ceiling is little, if any, over 20 feet high. The cave stream so nearly covers the floor that one must walk close to the wall and from time to time cross the stream to find a path on the mud banks, which border it first on one side and then on the other. If one does not object to getting wet it is thus possible to penetrate probably over half a mile into the recesses of the cave to a great room, 80 to 100 feet in diameter and with a ceiling 60 or 70 feet above the water. The stream here runs through a gorge made still more narrow by the fallen stone, which lies as if thrown down by some great convulsion of nature and seems ready to take another tumble if disturbed to the slightest degree. At one place the rock masses have blocked the stream so effectually that it is impossible to get a boat around them, and beyond is a large pool too deep to cross by wading. This room is practically



SKETCH MAP OF NICKAJACK CAVE.

a Wagon road crossing cave stream.
b Pool in front of cave.
c Entrance.
d Large stalagmite.
e Valley in which are two stalagmites.
f Labyrinth of small passages.
g Bank of large blocks of rock.
h Side passage with branches parallel to main cave.
i Side passage about 25 feet above level of stream.
j Wall of rock apparently ready to fall.
k Mass of rocks obstructing cave stream.
l Pool at limit of exploration.
m Possible continuation of passage.

the limit of exploration; but that the cave, probably as a large and easily traveled passage, goes much farther there can be but little doubt.

There is evidence on every hand that the cave is very old, and is now in its period of decline. There are no stalactitic formations of importance except at a point about 100 yards from the entrance where there is a large mound-like stalagmitic growth 6 or 8 feet high and perhaps 20 feet in diameter. In a series of pockets or basins on this stalagmite were found large quantities of "cave pearls," rounded concretionary masses of lime which had formed in the disturbed water without becoming attached to the sides or bottom. In several places in the cave there are immense heaps of loose rock piled from the floor to the ceiling, and in some cases large blocks seem to have fallen quite recently.

The cave stream, which has been already mentioned, flows through the entire length of the cave, so far as it is known, and is of practically uniform size and depth throughout. It receives no tributaries, but makes its appearance in the large pool at the end of the cave, apparently boiling up from beneath the rock wall, and flows toward the mouth of the cave with a good current. It is bordered first on one side and then on the other by mud banks, the side next to the bank being shallow, while the side next to the rock wall will average 3 or 4 feet in depth. The large pool just mentioned seems to be quite deep, but as it was not possible to launch a boat upon it it was also impossible to sound it.

Two visits were paid to the cave, each extending over several days. At the time of the first visit, heavy rains having recently fallen, the water in the cave was so high as to preclude the possibility of collecting. The net result of six days work was a single pair of blind crayfish. The second visit, some ten days later, was more successful, as, the water having subsided, it was possible to get from one part of the cave to another and to work in the stream itself.[1]

Less famous than Nickajack Cave, but at the same time widely known, is a rather small cavern known as Lookout Cave, which runs for some distance back under Lookout Mountain. The entrance is reached from the Nashville, Chattanooga, and St. Louis Railroad tracks not over a mile from Chattanooga. The passage a short distance from the entrance becomes quite narrow, but a little farther on widens and becomes higher so that it is quite commodious. The route gradually descends to the level of the river outside and at last meets a small subterranean stream along which one can wade for some distance in either direction. I was able to visit this place but once and then found the water too muddy for successful collecting. In one deep hole, however, I saw a very pale-colored salamander about 15cm in length. It may have been a larval form of some out-of-door species, but it looked quite unlike any with which I am familiar. It swam away with such rapidity when I attempted to secure it that it soon disappeared in the muddy water.

---

[1] Cope and Packard, The Fauna of the Nickajack Cave, American Naturalist, XV, 1881, p. 880.

At Rossville, Georgia, I was able to penetrate a few feet into a small cave at the "John Ross Spring." At Shellmound I paid two visits to what is known as the Wine-house Cave, a treacherous hole of 85 feet almost perpendicular depth, filled with loose rock masses of all sizes. The passage at the bottom of the cave is very short, but contains several pools of water which will probably be found to contain about the same fauna as the stream in Nickajack Cave.

During the interval between the two visits some collecting was done at Rossville, Georgia, and in the immediate vicinity of Chattanooga. The results of that work are included in this report.

II.—REMARKS ON ANIMALS, OTHER THAN CRUSTACEA.

In addition to the light-colored salamander mentioned above I observed several other animals, which may be referred to here, as they will not find a proper place in the body of the paper.

In the Wine House Cave I saw a small white fish which, from its actions, I took to be a blind species, but it was quite unlike *Amblyopsis* and may belong to some unknown species. Here also I secured one specimen of the cave salamander, *Spelerpes maculicauda*.

In Nickajack Cave there were hundreds of bats, and in their dung, which covered the floor and rocks in some places to a depth of several inches, I found numerous small Lepidopterous insects in appearance very like the ordinary clothes moth. Cave crickets (*Hadenœcus subterraneus* Scudder) were common, but nowhere abundant. In the stream I noticed a few small minnows and many blobs (*Cottus* sp.). Here I also found a good-sized water snake (*Natrix* sp.) swimming about in a most confused manner. A day or two later I found a butterfly *Neonympha gemma* perched upon the wall of a narrow and totally dark side passage. The snake and butterfly were undoubtedly accidental visitors to the cave. The others, with perhaps the exception of the blobs and minnows, were permanent inhabitants.

III.—CRUSTACEA.

Suborder ISOPODA.

Family ASELLIDÆ.

Genera MANCASELLUS Harger and CÆCIDOTEA Packard.

CÆCIDOTEA Packard.

While in this paper and a preceding one[1] I have used the name *Cæcidotea* for the eyeless subterranean Asellidæ, I have done so unwillingly, more out of deference to common usage than out of confidence in the validity of the genus. The case has been several times reviewed by various writers, but in view of the fact that in this paper several new facts regarding the species are brought forward I feel warranted in presenting a complete digest of all that has been said and adding thereto such remarks as my experience dictates.

---

[1] Observations on the Crustacean fauna of the region about Mammoth Cave, Kentucky. This volume, p. 223.

The genus *Cæcidotea* was erected in 1871 by Dr. Packard for the reception of the peculiar eyeless Isopod from the cave region of Kentucky. The original diagnosis was based on imperfect specimens which lacked the uropods and second antennæ, and the name *Cæcidotea* was intended to call attention to its affinity to the marine genus *Idotea*. However, a careful comparison of the structural details with this genus and with *Asellus communis* showed that these first ideas were erroneous and that the affinity lay with *Asellus* rather than *Idotea*. As the genus *Asellus* is a characteristic fresh-water form distributed, in North America, very generally throughout the fresh-water surface streams and ponds of the cave region, the probable very close relationship of the two genera *Cæcidotea* and *Asellus* and the probable descent of the blind form from the other became apparent. In 1876 Dr. S. A. Forbes[1] united it with *Asellus*, and in describing his investigations said "A detailed comparison of this species with undoubted *Asellus*, especially with the admirable plates of *A. aquaticus* in the 'Crustaces d'eau douce de Norvege,' has failed to reveal any structural peculiarities which could positively serve as the characters of a distinct genus." In 1881 Dr. Packard described a second species of this genus from Nickajack Cave, near Chattanooga, Tennessee, calling it *Cæcidotea nickajackensis*. At the same time he stated his opinion that the two species of *Cæcidotea* had sprung from two distinct species of *Asellus*. Five years later the same author, in his monograph of the Cave Fauna of North America,[2] defends his genus, and this defense has apparently been sufficient to cause all subsequent writers to accept it. He says:

> It remains to be seen, however, whether Mr. Forbes has not somewhat overstated the case and whether there are not a number of structural peculiarities which forbid our placing the two known species in the genus *Asellus*. It should be observed that not only are *Cæcidotea stygia* and *Cæcidotea nickajackensis* without eyes, but that the body and appendages also differ a good deal from any of the known species of *Asellus*. The genus seems as well founded as many others in the Isopods and other groups of Crustacea. We have little doubt but that *Cæcidotea* has by modification and heredity been derived from *Asellus*, but because this is most probable it is no reason why, from a systematic point of view, we should disregard its evident generic characters; for it is now generally believed that somehow all the genera of Isopoda have descended from some primitive form or genus. Because, then, we do not know with some degree of certainty that *Cæcidotea* has recently diverged from *Asellus*, and can see that the generic characters it possesses have been the result of its underground life, we should yet, from a purely taxonomical point of view, regard it as a good genus. Of the genus *Crangonyx* some species are blind and others are not, but the blind species do not present other important differences. It is so with the species of *Phalan-*

---

[1] Bull. Illinois Mus. Nat. Hist., 1, 1876, p. 11.

[2] Mem. Nat. Acad. Sci., IV., p. 30.

godes, where the loss of eyes is not always accompanied by other changes in form and structure, and so with other cases.

If we turn to the European *Asellus forelii* Blanc, a blind species from the abysses of Lake Leman, we see that it does not belong to our genus *Cæcidotea*, although it has been referred to *Cæcidotea* by Fuchs in his paper on the fauna of the deep sea. *Asellus forelii*, compared with specimens of *Asellus aquaticus* from Belgium, is about half as long and broad as *A. aquaticus;* the body has retained about the same proportions; the telson (abdomen) is little, if any, narrower or elongated. Both branches of the caudal stylets are of about the same length as in *A. aquaticus*. *Asellus forelii*, then, appears to us to be evidently a depauperated species, closely allied to *A. aquaticus*, which has lost its eyes by its life in supposed perpetual darkness at or near the bottom of Lake Geneva. Its generic characters are identical with those of its parent form, *A. aquaticus*. So also are those of *A. cavaticus* Schiödte, found in wells in Germany, and which closely resembles *A. forelii*, only differing in slight specific characters. It is evident that these two blind species were originally derived from *A. aquaticus*, and hence have retained the generic characters and specific marks of that European species as compared with our American *A. communis*.

When, however, we turn to our *Cæcidotea stygia* and *nickajackensis*, we find that they are not only not congeners of the blind European *Aselli*, but that they are also not congeneric with the American *Asellus communis*, and that there are no intermediate forms connecting them, although the eyed species of *Asellus* are somewhat variable. Hence, we feel warranted, on taxonomic grounds, whatever may be our theory about their origin, to retain the genus *Cæcidotea*.

Since the above was written, three species of *Asellus* have been described, *Asellus hoppinæ* Garman, *Asellus tomalensis* Harford, and *Asellus attenuatus* Richardson; the former from southwestern Missouri, the second from California, and the latter from the Dismal Swamp. There is probably still another species, as yet undescribed, which occurs in the District of Columbia. The Southern States have been very poorly explored for their fresh-water crustacean fauna, and there can be no doubt that when the work is undertaken many additional species of *Asellus* will be brought to light. They, therefore, are more abundant than Packard supposed, and exist, probably, as distinct species in nearly every cave region.

Dr. Packard's claim "that the two or three species of '*Cæcidotea*' are congeneric among themselves on one hand and generically distinct from the genus *Asellus* on the other," is a statement which we could understand had he not followed it up with the statement that "the species have probably arisen independently." A genus, according to the usual conception, is a natural aggregation of species and not a heterogeneous assemblage of species, grouped together simply because they happen to resemble each other. That such heterogeneous genera do exist and are accepted is quite probable, but they are accepted because we know nothing more of the animals than that they look alike. The genus *Cæcidotea* presents a case in which, in spite of the lack of good generic character and the very strong probability—one might almost say certainty—that the species are not of similar origin, carcinologists have been willing to group them together. In this connection we are strongly reminded of the effort of Cope to establish the genus

Orconectes to contain the blind crayfishes. These in their way possess the very characters which have been given generic value in *Caecidotea;* they are white, eyeless, and more elongate than the surface dwellers, but there can be no doubt that the five or six known species of blind crayfish have had an altogether independent origin and are less closely related to each other than to species with eyes living outside the caves. The remarks of Hagen[1] regarding the invalidity of the genus *Orconectes* may very well apply here.

On looking at the general characters of cave-inhabiting animals it will be seen that nearly all have been affected in the same general way: loss of color, more or less complete degeneration of the eyes, and a corresponding hypertrophy of the tactile organs are characteristic.

In some groups (for instance, the *Amphipoda*) there have been found intermediate forms between the surface and true subterranean varieties, but so far this has not been accomplished with the Isopods. Packard mentions a case, however, which is extremely suggestive: a specimen of *A. communis* from a well in southern Indiana was bleached perfectly white, but retained all the other characters of its species. It is a well-known fact that occasionally *C. stygia* has on the top of its head, where its eyes should be, a few facets, showing that the loss of eyes has been so recent that individuals occasionally revert to the primitive characters. However, there is lacking at the present time the positive evidence that this genus is not a natural one, or that we find here a case of the independent development of similar characters. I therefore accept the genus on the grounds of convenience, feeling certain that future investigations will throw light on its origin.

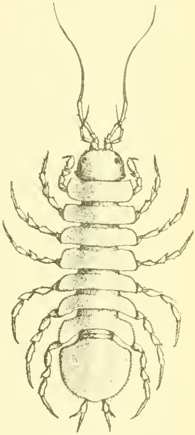


FIG. 1.—MANCASELLUS MACROURUS.

MANCASELLUS MACROURUS Harger.

This species was obtained in some abundance at various localities in the region visited. I found it first in the John Ross spring at Rossville, Georgia, where it inhabited the cold water close to the rock crevices from which the spring issued. Beyond 20 or 30 feet downstream it ceased to occur. At Nickajack Cave it was fairly abundant just outside the cave, on the under side of flat rocks and in the crevices of decaying logs of wood. It was most common in a dimly lighted crevice at the mouth of a tunnel-like outlet for the pool at the front of the cave, where in a few minutes I picked some fifty specimens from some submerged driftwood. The congregation at this point may have been due to the presence of the driftwood, but this was also abundant in better lighted locations and did not seem to be inhabited by the crustaceans.

---

[1] Hagen, Amer. Nat., VI, 1872, p. 494. Note also the genus *Stygobromus* Cope, for the subterranean *Gammaridæ*, Amer. Nat., VI, July, 1872, p. 422.

CÆCIDOTEA RICHARDSONÆ Hay.

It was confidently expected that one result of the reexamination of Nickajack Cave would be the collection of the various species of animals described from this locality by Packard,[1] but it was not until the last day of my visit that I was able to find what I supposed to be his *Cæcidotea nickajackensis.* A few specimens were collected; and on a critical examination it quickly became evident that either the description and figures of Dr. Packard's *C. nickajackensis* are altogether at variance with the facts or my species was a distinct one. As Dr. Packard's types have been lost, it can not be satisfactorily determined which is the proper view to take; but for many reasons, some of which are given below, the latter seems to be the only acceptable one.

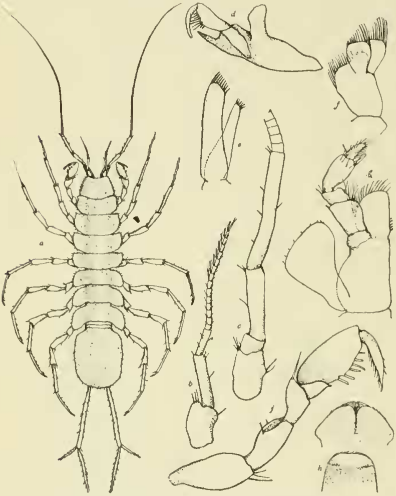


FIG. 2.—CÆCIDOTEA RICHARDSONÆ HAY.

a Dorsal view of entire specimen × 6.
b First antenna.
c Second antenna.
d Mandible.
e First maxilla.
f Second maxilla.
g Third maxilliped.
h Upper lip.
i Lower lip.
j Gnathopod.

Description.—A preliminary description of the new species was published soon after my return to Washington;[2] but now that figures have been prepared, it seems desirable to describe it in detail.

To a certain degree the general aspect is that of *C. stygius;* the animal is slender, white, eyeless. The slenderness, however, is much more pronounced, and the long, sprawling legs recall strongly certain of the *Ligiidæ.* The whiteness, and especially the apparent frailty of the body, is much more noticeable than in *C. stygius.*

The body is flattened quite as strongly as any member of the genus, being slightly convex along the median line only. The greatest

---

[1] Packard, The Fauna of Nickajack Cave, Amer. Nat., XV, 1881, p. 880.

[2] Proc. Biol. Soc. Wash., XIV, 1901, p. 180 (*Cæcidotea richardsonæ*).

breadth is at the last thoracic segment, and the greatest length, exclusive of appendages, is about four times the greatest width.

The head is considerably broader than long, concave in front, convex on the sides, and with a small, indistinct lobe near the outer posterior angle.

The first body segment fits the head very closely, but the anterior corners are slightly produced and the posterior portion of the lateral border somewhat swollen, so as to leave a rather prominent sinus a little in front of the middle of the border. The second segment is more nearly straight along the anterior margin, has sharp anterior and broadly rounded posterior angles. The third segment is quite similar to the second. The fourth segment is still of the same general character as the preceding, but is more nearly alike anteriorly and posteriorly than any of the other segments of the body. The fifth, sixth, and seventh segments have their lateral expansions directed backward, slightly in the fifth, and more strongly in the seventh.

Behind the seventh segment can be seen two very small annular segments of the abdomen.

The telson is one-fourth longer than broad and about one-fourth longer than the greatest width of the body. All its angles are broadly rounded and its upper surface is only slightly convex.

All the segments of the body and the head and telson are thickly covered with fine, short, bristle-like hairs, which project in every direction. They are most evident about the margins of the body, but may be found everywhere.

The antennule is about as long as the peduncle of the antenna. The basal segment is broad and somewhat enlarged distally. The second segment is long, cylindrical; the third is shorter. The flagellum is composed of about fifteen segments, all of which bear one or two slender setæ at the distal border, and the outer seven or eight bear, in addition, each a single spatulate sense organ.

In the antenna the first two segments are short, the third slightly longer than the first and second combined, and the fourth is as long as the first, second, and third taken together. The flagellum is very long and slender, so that the entire antenna is fully as long as the body. The mandibles have a cutting edge and a broad grinding surface. The palpus is well developed and provided with a strong hand-like extremity.

The maxillæ and maxillipeds do not present characters of importance.

The first pair of ambulatory legs (gnathopoda) are enlarged and subchelate. The hand is broad, inflated, and convex; the dactyl is strong and has an acuminate, somewhat sinuous, tip, and is provided, especially along its opposable margin, with stiff bristles. It shuts against the hand between two rows of strong spike-like teeth. The carpal segment is produced and spiniform at its outer distal angle. The meros bears on its tip a slender spine almost as long as the segment.

The succeeding pairs of walking legs are slender, hairy, and end in very slender, acute, claw-like dactyls.

The uropods are about one-half as long as the body. The basal segment is slender, subcylindrical, straight or slightly curved, and the terminal segments are slender and gradually tapering from the base to the end. The outer of these terminal segments is not much over half as long as the inner. In a perfect specimen the inner is considerably over half as long as the basal segment.

Length of body and uropods about 20 mm.

Habits.—Although I was able to learn comparatively little about the habits of this animal, the little I got is of interest and will serve to contrast this species with its relatives. They were found clinging to the under side of flat rocks well out in the cave stream, where the current was strong and the depth usually over a foot. Their movements were rapid, and they seemed to have no difficulty in running from one place to another over the rocks, retreating always to the lower side and hiding beneath some convenient angle. As a last resort they would loosen their hold on the rock and float away in the water. When in their native element, their sprawling legs and quick movements were very noticeable. When removed from the water they were absolutely helpless, not even having strength sufficient to raise their legs or straighten out their bodies.

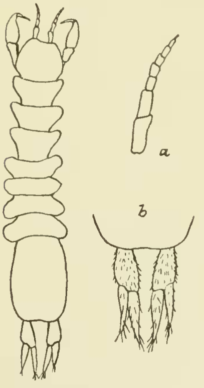


Fig. I.—Cæcidotea nickajackensis Packard.

a Antennule; *b* Caudal stylets. After Packard.

Comparison and distribution.—*Cæcidotea nickajackensis* Packard, from the same locality, is described as follows:[1]

> Body longer, narrower, and slenderer than in *C. stygia*. The antennæ are sometimes very long and reach to the end of the third joint of the second antennæ; they are sometimes nearly twice as long as in *C. stygia*, and are purplish white, while the flagellum is provided with long hairs.
>
> The second antennæ are as long as the head and extend backward as far as the base of the abdomen. The legs are much longer and slenderer than in *C. stygia*. The abdomen is long and narrow, and the caudal appendages are moderately long in one specimen and short in another. In one individual the outer branch is much shorter and smaller than in the others, and in most it is as long as the basal joint. On the whole, the caudal appendages are no longer than the telson or terminal segment of the abdomen, while in *C. stygia* they are half as long as the entire body.
>
> This species forms in the antennæ and slightly purplish color and the proportions of the leg joints perhaps a

---

[1] Packard, The Cave Fauna of North America, Mem. Nat. Acad. Sci., IV, 1887.

nearer approach to the genus *Asellus* than that of Mammoth and Wyandotte caves. On the other hand, *C. stygia* approaches *Asellus* more in its shorter, broader body, with the shorter, broader abdomen. It seems quite evident that the two species must have descended from different species of *Asellus*. Whether there is an additional species in the Southern States from which the present species may have been derived remains to be seen.

From the above description it would seem that the chief difference between *C. nickajackensis* and *C. richardsonæ* lies in the character of the uropods, but a reference to the figures accompanying Dr. Packard's description shows several more important characters in which this species do not correspond with the present one. The first antennæ are short and have a flagellum composed of not more than seven segments; the present species has about fifteen. The outline of the head and body is quite different, though this may be due to faulty drawing. The shape of the telson is very different, being much longer in proportion to the length of the body and its own width than in *C. richardsonæ*.

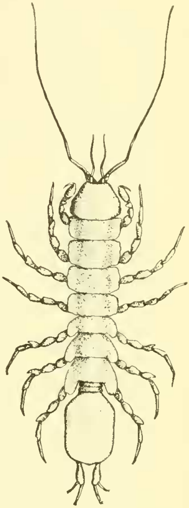


FIG. 3.—CÆCIDOTEA NICKJACKENSIS, METCALF, GEORGIA.

During my examination of the new species Miss Harriet Richardson kindly furnished me with specimens of an eyeless *Cæcidotea* from Metcalf, Georgia, which she has identified as *C. nickajackensis* Packard.

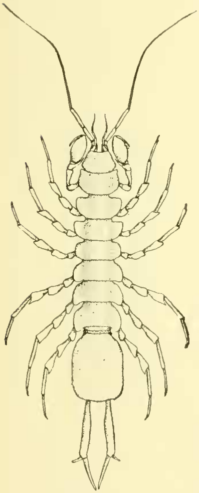


FIG. 4.—CÆCIAOTEA STYGIA PACKARD, MAMMOTH CAVE, KENTUCKY.

It seemed rather improbable that the species should appear in two localities so far apart as the northern and southern limits of the State of Georgia, but a careful comparison with Packard's description and figures showed that it corresponded very well, although differences are still to be found in important characters. Regarding them, in the absence of better proof,[1] as *C. nickajackensis* Packard, we find the following differences between *C. richardsonæ* and *C. nickajackensis:*

C. nickajackensis has the first antennæ shorter, composed of about

---

[1] The Metcalf specimens may represent a distinct species, in which case it may be known as *C. troglodytes*. Type, No. 26186, U.S.N.M., Metcalf, Georgia.

ten segments, *C. richardsonæ* has fifteen. The second antennæ are shorter, not equaling the length of the body; in *C. richardsonæ* they are longer than the body. The sides of the body are nearly parallel, the head nearly, if not quite, as wide as the broadest segment. In *C. richardsonæ* the body is widest in the middle and tapers toward each end; the head is considerably narrower than the first body segment. In *C. nickajackensis* the telson is long, with slightly concave sides, and the uropods are short, their basal segment is enlarged at its distal extremity, and the terminal segments are about as long as the basal portion; there are tufts of bristles at the ends of the terminal segments and a very few rather large bristles along the margins of both basal and terminal segments. In *C. richardsonæ* the telson is convex sided and shorter, the uropods are very long and slender and thickly covered with short bristles, the basal segment is fully as long as the telson, and the terminal segment half as long. There are differences also in the appendages, but the above are sufficient for our purposes.

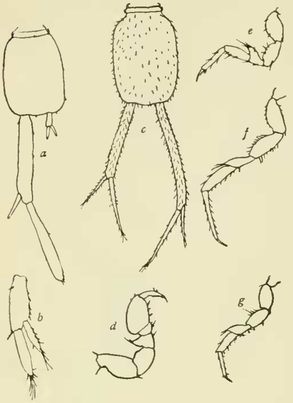


FIG. 5.—THE THREE SPECIES OF CÆCIDOTEA.

a Telson and uropoda of *C. stygia* (Mammoth Cave).

b Uropod of *C. nickajackensis* (Metcalf, Georgia).

c Telson and uropoda of *C. richardsonæ* (Nickajack Cave).

d Gnathopod of *C. nickajackensis* (Metcalf).

e Fifth pereiopod of *C. nickajackensis* (Metcalf).

f Fifth pereiopod of *C. richardsonæ* (Nickajack Cave).

g Fifth pereiopod of *C. stygia* (Mammoth Cave).

Compared with the well-known *C. stygia*, the specimens from Metcalf seem to resemble that species rather than *C. richardsonæ*, but the differences are great enough to show that it has descended from some other, but closely related, species of *Asellus*. In order that comparisons may readily be made, I have prepared figures of the three species mentioned and have copied Packard's figures of *C. nickajackensis*.

Family ONISCIDÆ.

Genus PORCELLIO.

PORCELLIO LÆVIS Latreille.

This species was found in great abundance under stones a short distance from the entrance to the cave. They were well known to the natives of the region, and are used by some of them as a medicine to produce an eruption in the case of hives, measles, and similar diseases. The recipe calls for "nine sow bugs crushed in a small quantity of lukewarm water." The dose is taken internally, and is said to be very efficacious.

Order AMPHIPODA.

Family GAMMARIDÆ.

Genera NIPHARGUS and GAMMARUS.

Under the generic name *Niphargus* Schiödte I place the species described as *Crangonyx antennatus*, by Dr. Packard,[1] as I find it agrees much more closely with that genus than with *Crangonyx* or *Gammarus*. As remarked by Chilton,[2] the genera *Crangonyx* and *Niphargus* are very closely related, differing only in the fact that the telson in the latter genus is divided, while in the former it is entire. In the present species the only parts in which there is a difference from the other species of the genus are the last pair of uropods, which do not have the outer branch excessively elongated.

Although the various species of *Niphargus* are well-known inhabitants of wells, springs, and subterranean water courses in the Old World, no species has heretofore been described from North America. That I do not claim the honor of being the first to recognize the genus in this country is due to the retentive memory and apparently limitless information of my esteemed instructor and friend, Dr. Theodore N. Gill, who has just called my attention to a mention of it in a list of the crustacea of the District of Columbia, published in a rather obscure work as long ago as 1861.[3] The name was evidently applied with some doubt, as it is followed by an interrogation mark. Dr. Gill was also able to give some interesting information regarding this citation and the specimen upon which it was based. The list of crustacea, it seems, was furnished by Stimpson, to whom, however, no credit is given in the book. The specimen (for according to Dr. Gill's recollection there was but one), which is called *Niphargus*, was sent in from some well near Washington, and in conversation Stimpson expressed himself as certain that it belonged to that genus. Unfortunately, no further reference was made to the species, and no other specimens have been obtained.

That other species of this genus have been observed in North America I do not doubt, but they seem in all cases to have been described as *Crangonyx*. The two genera are very closely related, and differ apparently only in the telson, which is entire in *Crangonyx* and divided in *Niphargus*. *Crangonyx bifurcus* O. P. Hay is a *Niphargus*; *C. lucifugus* O. P. Hay, *C. Packardi* Smith, *C. tenuis* Smith, and *C. vitreus* Smith seem to be correctly placed; *C. gracilis* Smith has the telson slightly emarginate, but not divided to any appreciable extent in any of the specimens which I have examined. *C. mucronatus* Forbes is

---

[1] Am. Nat., XV, 1881, p. 880.

[2] Trans. Linn. Soc. Lond., 2d ser., VI, pp. 218–220.

[3] Phelps's Washington Described, 1861, p. 34.

certainly neither *Crangonyx* nor *Niphargus*, but belongs to a distinct genus for which I propose the name *Bactrurus*. *C. flagellatus* Benedict differs from all the others in having the last two segments of the urosome coalescent, and therefore can not be a *Crangonyx*, but should stand as the type of a distinct genus which may be known as *Stygonectes*.

NIPHARGUS ANTENNATUS (Packard).

The specimens from which this description is written were taken at various places within Nickajack Cave, and undoubtedly represent Packard's *Crangonyx antennatum* described from this locality in 1881.[1] They differ slightly in the specific character and belong to a different genus, but these differences are of such a nature as to make it seem probable that they are the result of the poor material from which Dr. Packard wrote his description.

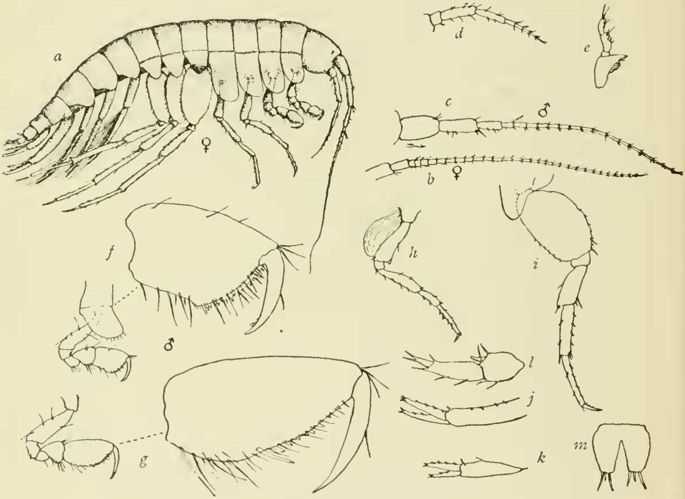


FIG. 6.—NIPHARGUS ANTENNATUS.

a Right lateral view of adult female.
b First antenna of female.
c First antenna of male.
d Second antenna.
e Mandible.
f First pereiopod.
g Second pereiopod.
h Third pereiopod.
i Fifth pereiopod.
j First pleopod.
k Second pleopod.
l Third pleopod.
m Telson.

Body slender, smooth. Head more elongate and less deep than usual in this genus. Eye composed of a few slightly pigmented facets

---

[1] Am. Nat., XV, 1881, p. 880.

or wanting altogether, when present of no definite shape. First antenna more than half as long as the extended body; with a small secondary flagellum of about two articles; the flagellum is more than twice as long as the peduncle and composed of about sixteen segments in the male and twenty-nine in the female. Second antenna short, not half as long as the first antenna, flagellum not much longer than the second or third segments of the peduncle, composed of five or six articles.

First pair of legs of the male with the carpus broad, triangular, and armed with numerous stiff hairs, most of which stand near the inferior angle. Propodus subquadrangular, broadest distally, and possibly a little produced at the inferior distal angle; inferior margin with a number of stout hairs; palmar surface with a deep groove, on each side of which are a number of strong teeth and stiff hairs. Dactyl curved and strong, as long as the palmar surface; in the female these parts differ in being smaller and less strongly armed than in the male.

Second pair of legs of the male with the carpus similar in general form and armature, but proportionally broader and stouter. Propodus considerably larger than that of first pair of legs and elongate, twice as long as broad; the greatest width is at a point about one-fourth of the distance from the posterior end, and from this point the width of the segment narrows rapidly and nearly uniformly to the base of the dactyl; the superior margin is slightly convex; the inferior margin, the shape of which has already been described, is posteriorly provided with a considerable number of long, stout hairs, while the palmar surface, extending over two-thirds of the infero-anterior margin, has a few bristles and ten or more strong teeth in two rows between which the dactyl can be closed; of these teeth the inferior one or two are much larger than the others; the dactyl is larger and stronger but less curved than that of the first pair of legs. In the female the second pair of legs is only slightly larger than the first pair, and the armature of the propodus is weak.

The fifth, sixth, and seventh pairs of legs are strongly developed and bear on their posterior margins especially an unusual number of fine, hair-like spines.

Epimera of the first four thoracic segments rather strongly developed, the fourth being unusually large and quadrangular.

Segments of the abdomen rounded above and without a trace of the spines characteristic of the genus.

Telson divided nearly to its base, each division truncate, and with three or four rather stout spines.

Posterior pair of abdominal appendages with the inner ramus short and rudimentary, the outer well developed and composed of two segments.

No marked variation is observable in the alcoholic specimens, except that in one example the eyes are entirely gone while in the others the eyes are present, but very small. Dr. Packard has called attention to the well-developed eyes; compared with other subterranean species they may be regarded as well developed, but when compared with the *Gammarus* in the pool just outside the cave their eyes are minute and not more than rudimentary. In the living animal a great variation was observable in the color, some being pure white while others were inclined toward the purplish spoken of by Packard. The original description of *C. antennatus* is here quoted, but it must be understood that the identification of my specimens with Packard's species has been on account of the correspondence of his figure and type locality rather than the description.

> It is a large and purplish species; the first antennæ very long; the flagellum with 20 to 24 joints; the entire antennæ being over one-half and nearly two-thirds as long as the body; the last joint of the peduncle being slightly more than half as long as the penultimate joint. Compared with *C. gracilis* Smith, from Lake Superior, it differs in the form of the eyes, the longer and stouter first antennæ, the flagellum having a greater number of joints, and in the different proportions of the joints of the peduncle. * * * The fourth pair of epimera are usually large and square. The telson, together with the caudal stylets, is much as in *C. gracilis*, but the rami are slightly stouter and more polished and the spinules a little stouter. It is probably a little larger species than *C. gracilis*, the specimens being 6 to 7 mm. in length; the eyes are not so distinct and are only one-fourth as large as in *C. gracilis*.

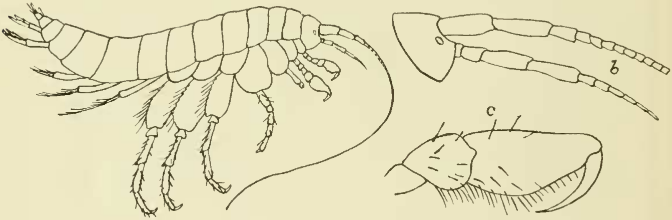


FIG. 11.—CRANGONYX ANTENNATUM.

b Head with base of upper and lower antennæ and eyes.
c Manus of second pair of feet. After Packard.

I first met with this crustacean well within the cave and beyond the point where the last traces of daylight were visible. They were found on a piece of decaying wood, but, although a number were seen, they were so active that only a few were obtained for preservation. I afterwards found them in various parts of the cave stream, always on decaying wood.

Although there are several rather important differences between my specimens and the description of *C. antennatum*, I have no hesitation in regarding it as Packard's species, as it agrees very well with the figures, but I find it must belong to the genus *Niphargus* of Schiödte rather than to *Crangonyx*.

GAMMARUS PURPURASCENS, new species.

Type.—No. 25544, U.S.N.M. Collected September 6, 1901, by W. P. Hay, at the mouth of Nickajack Cave, Shellmound, Tennessee.

Eyes large, reniform, with the concavity anterior. Head large, deep, notched in front for both antennæ, and with a very short rostrum. First antennæ about half as long as the body, with a small secondary flagellum of three articles; flagellum with from twenty to thirty articles; all the basal segments and those of the flagellum plentifully provided with hairs. Second antennæ a little over half as long as the first pair; first basal segment short and broad, second and third short, the second with a spine on the inferior margin; fourth and fifth segments of nearly equal length, each longer than the first three segments together; flagellum, composing about one-third of the appendage, of nine articles. All these segments, like those of the first antennæ, are plentifully provided with stiff hairs, and the segments of the flagellum bear, in addition, each a particular mushroom-shaped sense organ.

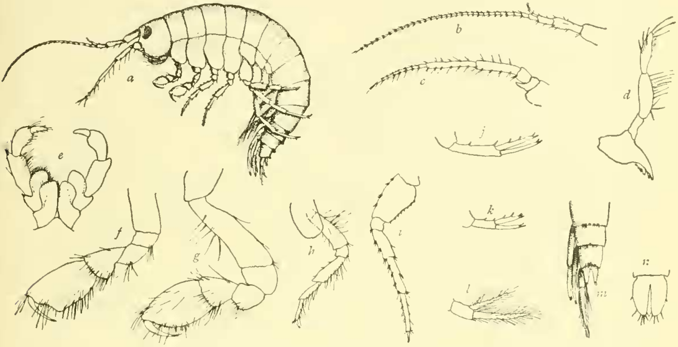


FIG. 7.—GAMMARUS PURPURASCENS, NEW SPECIES.

a, Left lateral view of adult male.
b, First antenna.
c, Second antenna.
d, Mandible.
e, Third maxillipeds.
f, Legs of second pair.
g, Legs of first pair.
h, Legs of third pair.
i, Legs of seventh pair.
j, appendage of eleventh segment.
k, Appendage of twelfth segment.
l, Appendage of thirteenth segment.
m, Dorsal view of abdomen and appendages.
n, Telson.

First pair of legs of the male strong, but of slightly smaller size than those of the second pair. The carpus is short and broadly triangular; its distal margin, especially near the inferior angle, is abundantly supplied with long bristles. The hand slightly broader than the carpus, its superior and inferior margins convex, the palmar surface very oblique and armed on each side with scattered spines and teeth between which the dactyl closes; the bristles on the hand are most abundant near the palmar surface and the distal end of the superior margin. The dactyl is about one-half as long as the hand, strongly curved and very acute.

The second pair of legs differs from the first not only in size but in the shape of all the segments and their armature of hairs and bristles. The carpus is more perfectly triangular in profile, but has an almost exactly similar arrangement of bristles. The hand is somewhat quadrangular; its superior and inferior margins are subparallel and the palmar surface is only slightly oblique; there are a few teeth and hairs at the sides of the palmar surface, another small bunch of slender hairs near the articulation of the dactyl, and a rather extensive patch of stiff hairs on the inferior margin. The dactyl is straighter than in the preceding appendage and more blunt.

The other pereiopods are similar to those of the *Gammaridæ* except that the third and fourth are very hairy and the fifth, sixth, and seventh have the basal segments much narrower, broadest at the proximal end and gradually narrowing distally.

Segments of the abdomen rounded above, the fourth, fifth, and sixth with the posterior margin slightly produced in three places—one in the middle and one very near the middle line on each side—and armed with three small clusters of spines. The spines of the middle clusters are rather smaller than those of the side clusters.

Both rami of the posterior caudal stylets with many slender hairs but no teeth.

Telson divided almost to the base; each division with a spine near the middle of the outer margin and a series of about five at the distal extremity.

This species resembles *Gammarus limnæus* Smith, but has much longer antennæ, larger eyes, differently arranged spines, and a different telson. Judging from Smith's figure[1] the posterior caudal stylets are much longer in *G. limnæus*. The second antennæ of *G. purpurasceus* have fewer segments than *G. limnæus*, but the difference is more than made up by the very numerous segments of the first antennæ.

The variation in the number of segments in the first antennæ is apparently dependent upon sex and age; they are longest in fully adult males, slightly shorter in adult females, and shortest in the young, without distinction as to sex.

I found this species quite common among the growing vegetation and decaying wood in a pool at the mouth of the cave. In color they were a dark purplish gray and their movements in the water were very quick, so that their capture was quite difficult. I also found them in the spring at Rossville, Georgia, but of smaller size and in fewer numbers.

---

[1] Rept. U. S. Comm. Fish and Fisheries, 1872–73, p. 651, pl. II, fig. 6.

Order MACROURA.

Family ASTACIDÆ.

Genus CAMBARUS.

CAMBARUS BARTONI CAVATUS, new subspecies.

Type.—U.S.N.M. 25017. Powell R. Tazewell, Tennessee.

Distribution.—Eastern and central Tennessee.

Similar to *C. bartoni*, but with broad, parallel sided, deeply excavated rostrum; the appearance of deep excavation being partially given by the unusually high elevation of the margins of the rostrum. The areola is narrower and more thickly punctate than in *C. bartoni bartoni* and the epistoma is triangular. The antennæ extend almost to the end of the abdomen and the carapace is more nearly cylindrical.

While, as in all the other subspecies of *C. bartoni*, there is quite a little variation noticeable in this form, the characters given above will be found to hold good in the majority of cases. Intermediates with the Kentucky or Virginia forms must of course be expected.

There are in the United States National Museum specimens of this subspecies from the following localities in Tennessee: Tennessee River near Knoxville and Chattanooga; Balls Creek near Tazewell; Indian Creek near Cumberland Gap, and Powell River at Tazewell. The latter, which have been selected as the types, have the characters of difference most marked.

I found this crayfish in small numbers in the cold water flowing from the John Ross Spring at Rossville, Georgia. One large female carried young.

CAMBARUS HAMULATUS Packard.

The crustacean of the greatest interest to me in Nickajack Cave was the blind crayfish, *Cambarus hamulatus*, described by Packard.[1] The first specimens were observed during my first visit to the cave; a male and a female about 45 mm. in length were found on a mud bank at the edge of the water. No more could be collected during the first week, although repeated search was made in all possible localities.

At the time of my second visit to the cave, after the water had fallen and was clear again, a specimen was occasionally observed. But it was not until I began to look for them under the rocks in the cave stream that I found how common they were. They appeared habitually to live under such, where they had scooped out a cavity in which to lie and from which they seemed seldom to travel. When disturbed, if they sought to escape, it was by crawling away rather than by swimming, and they would seldom move more than a few feet. Most often, however, they would lie perfectly still, and after the cloud of mud caused by raising the stone had cleared away, they could be seen lying quietly in their cavity or treading the mud to avoid being covered up. They were easily caught in the hands, as even after they had been touched they made no great effort to get out of danger. Indeed, in one case, I let a large specimen drop back into the water and a minute or so later found it lying at my feet; it had sunk like a stone and had not tried even to crawl away. They seemed to be totally devoid of the senses of sight and hearing, and the sense of touch did not seem to be nearly as well developed as in *C. pellucidus.* I tried many experiments to determine these points, as well as those regarding the habits mentioned above. As is well known, *C. hamulatus* differs considerably from *C. pellucidus* and is more closely related to such forms as *C. bartoni* or *C. latimanus*, which are surface dwellers and provided with well-developed eyes. Nevertheless, the general appearance is so strikingly like *C. pellucidus* that without a careful examination it would be exceedingly difficult to distinguish the two species. Compared with the two other blind crayfishes from this country, *C. setosus* and *C. acherontis*, the resemblance is less marked and the greatest difference is noticed between *C. hamulatus* and *C. setosus.* Yet *C. setosus* is the closest relative of *C. hamulatus*, while *C. pellucidus* and *C. acherontis*, which are very dissimilar in general appearance, are closely related. These facts are cited to show that there are apparently certain characters in the crustacea which readily lend themselves to modification under subterranean influences, but which mean very little when it comes to detecting family, generic, or specific relationships or differences. Sense organs and color may change with such rapidity that the animal becomes a true spelæan species before it is able to so change its habits as to become perfectly adapted to a subterranean life. Thus, I would regard the habit of living under stones of *C. hamulatus* and *Cæcidotea richardsonæ* as a primitive instinct to which the animals cling in spite of the fact that it is useless. *C. pellucidus* is probably an older species and has adapted itself more perfectly to conditions in the caverns where no special concealment is necessary.

---

[1] *Orconectes hamulatus* Packard, Amer. Nat., XV, 1881, p. 880.

As to the ancestry of *C. hamulatus* we would most willingly look to some species of the *C. bartoni* group, which occurs in this region, and of the three which are known to occur, *C. bartoni*, *C. latimanus*, and *C. extraneus*, the latter is far more like *C. hamulatus* than either of the other two. There is, however, another species, *C. jordani* Faxon, which in some characters agrees still more closely with *C. hamulatus*, and its range is not so far away as to make it impossible that it will still be found in the same territory. The wide and long areola, the lateral and branchiostegial spines of the carapace, the flat rostrum with lateral spines and long acumen, triangular epistoma, long antennæ (even longer in *jordani* than in *hamulatus*), the shape of the antennal scale, the development of hair on the inner faces only of the third maxillipeds, and the long fingers are all characters in which the two resemble each other. They differ markedly in the shape of the carapace, areola, and hand, and the body and all the appendages in *C. hamulatus* are more elongate and slender. The characters of difference, however, are undoubtedly due to the subterranean influences and are to be explained as Dr. Lönnberg has explained the differences between *C. archerontis* and *C. clarki*.

Unfortunately we know only the second form male of *C. jordani* and any comparison of the rather peculiar annulus ventralis of the female of *C. hamulatus* with that of the other species is impossible.

Of this species a series of twenty-six was obtained from Nickajack Cave and one specimen from a small cave known as Wine House Cave, about three-fourths of a mile distant from Nickajack.

Altogether there are fifteen females and eleven males, and of the latter ten are in the second form and one first form.

In size the specimens range from 17 to 65 mm. in length, both the extremes being found in the females. Of the males the smallest is 33 and the largest 55 mm. long.

Very little variation is observable in this series, and such as there is is confined to minute characters; thus, in some specimens the cervical groove is arcuate, in others slightly sinuate; in some the acumen of the rostrum is very slender, in others stouter. In the larger specimens there are two or three smaller spines, which are less developed or wanting altogether in the smaller specimens.

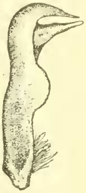


FIG. 8.—CAMBARUS HAMULATUS GONOPOD OF FIRST FORM MALE.

The first form male, which has hitherto not been observed, differs from the second form in having slighly stouter chelæ, the hooks on the third pair of legs are much stronger (in some of the second form males they are wanting), the basal segment of the fourth pair of legs is perhaps provided with a little larger knob, the first pair of abdominal appendages have the tips of the branches sharply recurved, the tips of the inner branch is slender, straight, and spiniform, and is directed backward at right angles to the rest of the appendage and a little outward; the outer branch is curved over the tip of the inner. it is thin and blade like and horny.

CAMBARUS LATIMANUS STRIATUS, new subspecies.

Type.—U.S.N.M. 25019. Nashville, Tenn. E. B. Williamson, collector.

Dr. Faxon[1] was the first to call attention to certain aberrant specimens of *C. latimanus* from Blount Spring, Cullman, and Bridgeport,

---

[1] Revision of the Astacidæ, p. 69.

Alabama, and Ashland, Cheatham County, Tennessee, in which the areola is reduced almost to a line in the middle, the metacarapace is longer in proportion to the procarapace, the fingers are shorter, the tuberculation of the hand weaker, the epistoma narrower and less strongly truncate.

Recent additions to the collection of the United States National Museum and the Museum of Comparative Zoology, of material collected near Nashville, Tennessee, by Mr. E. B. Williamson and a series of specimens collected by myself at Nickajack Cave show that we are dealing with a distinct geographical race of *C. latimanus*, the range of which extends over the eastern portion of Tennessee and northern portion of Georgia and Alabama.

It may be described as follows: Similar to *C. latimanus*, but with the rostrum a little more decurved and perhaps a little broader toward the tip. Suborbital angle rounded, branchiostegian spine developed, but very small, lateral spine of carapace usually represented by a denticle just behind the cervical groove. Areola linear, sometimes almost obliterated, its length equal to the distance from the cervical groove to the base of the rostrum. Epistoma triangular, not truncate, sides convex. Hands with one rather strong row of squamose tubercles along the inner margin and just above it another obscure row of much weaker tubercles, hand and, especially the fingers, deeply and roughly punctate, but not tuberculate, except as just mentioned. The carpus commonly bears strong median and small proximal internal spines and a rather blunt spine below at the distal border, but both this segment and the meros vary, as they do in the typical forms.

The specimens from Ashland City, mentioned above, belong to this subspecies, and the others are, in various ways, intermediate between the typical *C. latimanus* and those just described.

From a series sent alive to the United States National Museum the following color notes were taken, which are interesting in that they show that the same species may have at least two styles of coloration. The sexes were not distinctively colored and there was some variation in each style.

In one, the ground color, in fact nearly the entire body was a clear sage green shading into dirty gray brown on the sides and tail fin and into very dark-brown black on the sides of the head. There were a few blackish shadings on the angles and inner surfaces of the meros, carpus, and chelipeds. The margins of the rostrum, postorbital ridges and the tips of all the spines on the chelipeds and the tips of the fingers were ochre yellow. Beneath, the color was of a uniform light gray.

In the other style of coloration the ground color was a dark brown (near clove brown but not so red), becoming a little lighter on the head and fading into grayish on the sides. Beginning at the cervical groove and extending the full length of the abdomen, but not including the telson was a conspicuous light-brown stripe, widest on the carapace and with irregular and poorly defined margins, but on the abdomen pretty well defined. In addition to the median stripe, the abdomen had on each side a lateral stripe, well defined along its inner margin, but of uncertain limits outside. There was a faint suspicion of rusty yellow on the sutures in the external blade of the tail fin and the spines of the body were white. Beneath, the color was very light vinaceous.

In the summer of 1901 I found this crayfish in some numbers under the stones in a small pool formed by the stream issuing from Nickajack Cave. The males were all of the second form and both sexes exhibited the two-color phases mentioned above. Several of the specimens were brought alive to Washington, but most of them soon died. Two, a male and female, survived several months, living in a small bowl in which the water was frequently changed and food supplied from time to time in the shape of bits of apple and shreds of meat. November 15 the female shed her shell, but did not exhibit a perceptible increase in size. December 20 the male shed his shell and came out as form I, but without a marked increase in size.

It may be added that among the specimens collected at the mouth of Nickajack Cave, two of the second-form males had evidently shed their shells very recently; so, from evidence now at hand, it looks as if the second-form condition begins in August and lasts until December, but I am inclined to believe that the specimen kept in captivity had its ecdysis somewhat hastened by the unnatural conditions.

CAMBARUS SPINOSUS Bundy.

Specimens of this species (Males f. II and females) were obtained from a small stream flowing from a pond which, in turn, was fed by the cave stream known as John Ross Spring near the town of Rossville, Georgia. They agree very well with typical specimens, except as regards the length of the posterior portion of the carapace, which is a little more than one-half as long as the distance from the cervical groove to the lateral spines of the carapace.

In habits they seemed to be very similar to *C. propinquus* Hagen, living in shallow burrows in the soft mud, in shallow water, or in excavations under flat stones.